Irrigation Performance Guarantee

The irrigation brain trust broke the mold with a performance guarantee at Paradise Valley Country Club.

BY ROB COLLINS, BRENT HARVEY, JIM WRIGHT, AND DR. PAUL BROWN

THE GOLF COURSE SUPERINTENDENT — ROB COLLINS

Several years ago, we exceeded our state water allocation and were facing possible fines. We set a goal to reduce water use by a robust 76 acre-feet (AF), a target that we felt was achievable if irrigation performance was substantially improved. However, green committee members at Paradise Valley Country Club (PVCC) wanted a guaranteed performance level, but such a guarantee had never been considered before among industry professionals. Irrigation designers, manufacturers, and researchers were challenged to forgo industry standards and guarantee an elevated level of efficiency.

The solution seemed simple enough; reduce irrigated turf, improve efficiency, and meet the water allotment. In 2006, the facility used 620 AF of water on 122 acres of turf, or 5.1 acre-feet/acre (AF/A). This total exceeded the water allotment by about 40 AF. As we began to evaluate potential solutions, more questions were raised. For example, how does irrigation efficiency affect water use? If we improve the efficiency by 10, 15 or even 20%, how much water is saved? How much turf can we remove without negatively impacting the design and character of the course? These were questions we were unable to answer ourselves, so we sought professional advice from Brent Harvey, of Harvey Mills Irrigation Design, from Jim Wright, with Toro Irrigation, and from Dr. Paul Brown, with the University of Arizona.

THE IRRIGATION DESIGNER — BRENT HARVEY, HARVEY MILLS DESIGN

As the irrigation designer, we were challenged by the board of directors at PVCC to guarantee their new system

Achieving DU values greater than 80% is rare on tee boxes where sprinklers are irregularly spaced and are located on slopes.

We found that DU on greens is typically the lowest of all areas audited (70% is common), due to spacing and slope irregularities.

TGIF Record Number 172076

A field location strategy was developed to maintain the precise head location during installation. This helped us maintain the 80% DU goal.

The key to accurate staking is good equipment. Both the GPS equipment (shown left) and the total station (shown right) are capable of sub-centimeter accuracy.

would operate at a high performance level. While we were confident that modern systems are capable of irrigating at distribution uniformity (DU) meeting or even exceeding 80%, guaranteeing such a high level of performance had never been done before in the golf industry. To that end, Harvey Mills Design constructed a comprehensive plan that addressed the PVCC club officials' desire to guarantee 80% DU.

Past project experience revealed that such a high level of performance is possible, but not without considerable effort. The design had to be precise, and the execution in the field had to be equally particular. The plan involved strict design guidelines, innovative staking principles, and an experienced team. Details of the plan are offered below:

- Forge commitment from either Rainbird™ or Toro™ irrigation to meet a minimum system performance of 80%.
- Assist in pre-auditing trial areas to prove the system can meet the performance goal.
- During construction, perform irrigation audits to ensure the minimum standard is being met.
- Through careful engineering of head layout, optimal spacing throughout the golf course was achieved.
- By using survey grade mapping instruments, each sprinkler head was staked to sub-centimeter accuracy.
- A mini-triangulation system was developed to protect the true location of each sprinkler in the field. Following lateral installation, the exact point of the sprinkler head was relocated with these fixed points.
- Post construction, irrigation audits continued to validate compliance with the 80% minimum standard.
- Moving forward, semiannual irrigation audits will be scheduled.

The result is the first-ever irrigation system guaranteed to either meet or exceed a minimum performance standard.

THE IRRIGATION MANUFACTURER — JIM WRIGHT, TORO IRRIGATION

Testing sprinkler performance in an outdoor environment presents many variables that can influence the distribution uniformity. Wind, pressure, spacing, sprinkler angle, and elevation changes all contribute to reduced efficiency. Sprinkler manufacturers conduct the bulk of their testing in very controlled, indoor environments to eliminate these variables and allow for more accurate comparisons of nozzle performance. While most of the variables aren't going to change (spacing, angle, elevation), wind is the one thing that can vary at any moment and can have a very negative influence on nozzle performance.

> ***We have gained peace of mind that the club is a good example of environmental stewardship***

At Paradise Valley CC, testing locations were selected to provide direct comparisons with areas evaluated prior to the renovation. A testing protocol was agreed upon and was typically performed at daybreak to minimize the wind effect. Specific parameters regarding the testing method are offered below:

- Test method complied with Irrigation Association Guidelines.
- Wind speed — 5 mph maximum.
- Water pressure — recorded at the mainline and at each sprinkler.
- Mainline — 10 psi above regulated pressure.
- Sprinklers level to grade; 2° maximum.
- Test run times must be consistent; 15 minutes minimum.
- Sprinklers run a minimum of 5 complete rotations.
- Sprinkler rotation times must be consistent.
- Sprinklers start and stop outside of collection area.
- Avoid main nozzle collisions.
- 32+ collectors — divisible by 4.
- Collectors located within 10 feet of a sprinkler were recessed to grade.
- Run all 8 (square pattern) or 9 (triangular pattern) supporting heads around the area.
- Fairway and rough areas were tested using a triangular collection grid.
- Distribution uniformity was calculated using the following formula:

$$DU = \frac{\text{Average catch in lower quarter}}{\text{Average catch overall}}$$

In fairways and roughs, 36 collectors were used to provide statistically valid sampling and be divisible by 4. In these areas, DUs above 80% were regularly achieved due to the consistently accurate head spacing. However, DU values in the mid to high 70% range were common around tee boxes. Changes in elevation, slope, and spacing irregularities reduce DU in such areas. Greens, as you would expect, have proven to be the most difficult locations due to their irregular shapes and resultant sprinkler spacing. Values achieved were typically in the low to mid 70% range.

The challenges associated with outdoor water audits identifies that an individual test result represents the conditions at that given point in time, but examining the same area multiple times will offer a more accurate reflection of the true performance. We recognize that these initial tests are only the beginning, and Mr. Collins has implemented a regular water audit program to continually assess the performance of the system and identify areas for improvement. Together, we will continue to work towards these improvements through water auditing, modeling, and soil sensing technologies.

THE PROFESSOR — DR. PAUL BROWN, UNIVERSITY OF ARIZONA

The green committee at PVCC asked for an independent assessment of the water saving they could expect if the distribution uniformity (DU) of their irrigation system improved from 62% to 80%. The traditional water saving calculation assumes that irrigation non-uniformity will be offset by overwatering dry areas. Figure 1 offers a graphical representation of this traditional approach. The blue curve in

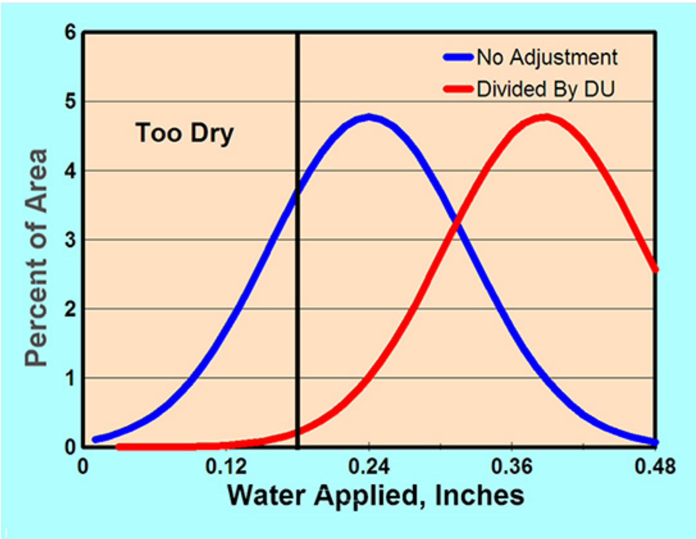

Figure 1. Area distribution of 0.24-inch depth of irrigation applied by a system with a DU of 62% (blue curve). The red curve shows nearly 0.39 inches of water is needed when dividing by the DU, a computation traditionally performed to address dry areas. The area to the left of the black vertical line represents the watering rate likely to produce dry areas and subpar turf.

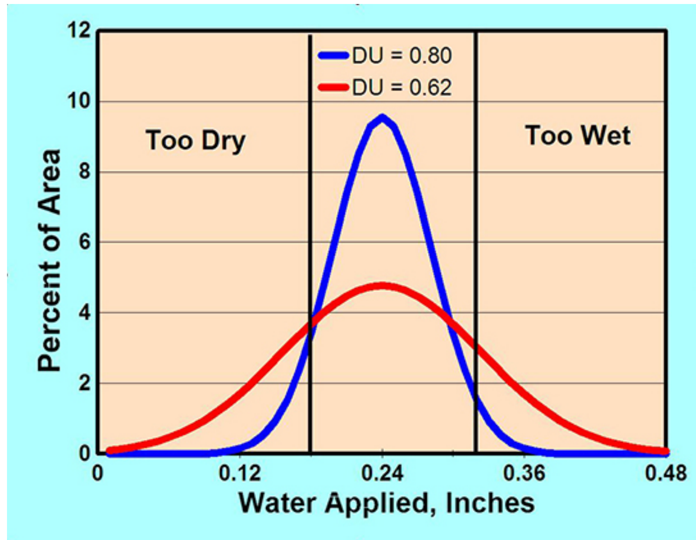

Figure 2. Area distribution of a 0.24-inch irrigation event when applied by systems with a DU of 62% (red curve) and 80% (blue curve). The area left (too dry) and right (too wet) of the vertical lines delineate water applications that would lead to poor turf performance or excessive wetness.

Figure 1 depicts the irrigation distribution when 0.24 inches of water is applied with a system operating at 62% DU. The red curve shows the impact of increasing the watering rate by dividing by the DU (0.24 inches of irrigation/0.62 = 0.39 inches of water). The same procedure generates 0.30 inches of water with a DU of 0.80 (0.24 inches of irrigation/0.80 = 0.30 inches of water). The result of such outdated computations is nearly 23% more water (0.39 inches compared to 0.30 inches) is applied to compensate for under-watered turf for the low DU system compared to the system operating at 80% DU.

Clearly, the traditional model did not offer a realistic solution; thus, a more pragmatic approach was then employed to address the water saving issue. First, the amount of additional water required to eliminate dry areas was calculated for systems with DUs of 62% and 80%. The calculation revealed a net saving of about 14% if the DU were to improve to 80% (Figure 2). A similar computation was then used to address wet turf on the golf course. In this situation, implementing tactics to reduce the wet turf areas of a low DU system would lead to a water saving of ~4%, since the irrigation system would produce a greater amount of wet turf than a high DU system (Figure 2). When combined, these two computations yield a net saving of about 10%, when system DU increases from 62% to 80%.

It is appropriate to question whether this procedure for estimating water saving represents an improvement over the traditional approach. When the analysis suggested here was applied to PVCC, with a system DU of 62%, facility water use was estimated at 5.15AF/A, just 2% under the long-term average use. This same analysis, when applied to the new PVCC irrigation system, with a DU of 80%, estimates total water use will drop to 4.64AF/A, a significant savings, and well under the water allotment. While both of these estimates appear more realistic than the values obtained using the traditional computation, the actual answer will emerge over the next few years in the PVCC irrigation records. In the end, we were able to dispel the misguided notion that increasing the DU by nearly 20% would result in 20% water savings. The analysis indicates the club should expect to see a water savings of 10%.

CONCLUSION — ROB COLLINS, GOLF COURSE SUPERINTENDENT

In 2009, we logged our first full year with the new irrigation system. The 501 AF used shattered our water use goal and was well below our water allotment of 580 AF. Water use decreased from 5.1 AF/A in 2006 to 4.5 AF/A in 2009 as a result of irrigation improvements and the removal of 10 turf acres. With rising water costs, this saving is significant. I give our committee members much credit for the success of our project. They had to learn a lot in a short time and make some difficult decisions. In the end, we have gained peace of mind that the club is a good example of environmental stewardship for the community, while continuing to offer conditions members have come to expect.

ROB COLLINS, superintendent, Paradise Valley Country Club; BRENT HARVEY, Harvey Mills Design; JIM WRIGHT, Toro Irrigation; PAUL BROWN, PH.D., University of Arizona.